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An Innovative Method of Power Generation using PV Technology on Solar Roadways

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Abstract: This is other approaches and methods of using solar photovoltaic technology on highways, for example, using solar-powered LED roadway lighting, security lighting, highway changeable message, etc. Although these are very important applications, in terms of power generation or power saving, they are almost negligible in comparison to the approach that it has suggested in this paper. Also, one can see the cost-oriented modeling and design optimization for alignment to determine operation and engineering cost of the highway.

Keywords: solar, LED, cost-oriented, optimization.

I. INTRODUCTION

This Solar energy, radiant light and heat from the sun, is harnessed using a range of ever-evolving technologies such as solar heating, solar photovoltaic, solar thermal electricity, solar architecture and artificial photosynthesis. Solar technologies are broadly characterized as either passive solar or active solar depending on the way they capture, convert and distribute solar energy. Active solar techniques include the use of photovoltaic panels and solar thermal collectors to harness the energy. Passive solar techniques include orienting a building to the Sun, selecting materials with favourable thermal mass or light dispersing properties, and designing spaces that naturally circulate air. Energy generation using solar photovoltaic requires large area.

As cost of the land is growing day by day, there is a strong requirement to use the available land as efficiently as possible. Here, we explored the potential of energy generation using the land above national road highways by constructing a roof structure. This space can contribute to the energy generation without extra cost for the land. It also results in energy efficiency, for example, improved vehicle movement and minimum energy for air conditioning of vehicles. Additionally, it also helps in minimum road repairs and longer vehicle tire life due to the effect of sun shade.

Thus, the expenditure for wear and tear for road repairs is reduced considerably. From our modeling study, it is observed that the highway can generate 104 MW of electricity (163 G Wh of annual energy generation) and the A highway space can generate 61 MW of electricity (96 G Wh of annual energy generation) for single-layer solar panels. If there are two layers of solar panels one over the other, the annual energy generation of the same highways, can be increased to 229 G Wh and 140 GWh, respectively. If our concept is implemented throughout India, it not only increases the power generation to more than a few giga watts of electricity but also has other various fringe benefits including longer road life, employment generation, reduced CO2 emission in environment, etc. A solar roadway is a series of structurally engineered solar panels that are driven upon. The idea is to replace current petroleum-based asphalt roads, parking lots, and driveways with solar road panels that collect energy to be used by homes and businesses, and ultimately to be able to store excess energy in or alongside the solar roadways.

Thus renewable energy replaces the need for the current fossil fuels used for the generation of electricity, which cuts greenhouse gases and helps in sustainable development. Parking lots, driveways, and eventually highways are all targets for the panels. If the entire United States Interstate Highway system were surfaced with Solar Roadways panels. The Solar Roadway is an intelligent road that provides clean renewable energy, while providing safer driving conditions, along with power and data delivery. The Solar Roadway will pay for itself through the generation of electricity along with other forms of revenue. The same money that is being used to build and resurface current roads can be used to build the Solar Roadways. Then, since coal-fired and nuclear power plants will no longer be needed, the costs of all electricity generation plants can also be rolled back into the Solar Roadways. Solar roadways without training, which in turn will raise the overall cost of the project. This is one major detriment to the Solar Roadway concept. Our broad vision of the concept of solar roadways is to ultimately replace all drivable, impermeable surfaces, such as asphalt roads, with energy producing solar panels.

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II. LITERATURE SURVEY

1. From the study of cost economics of a solar photovoltaic power plant, the PV module cost is about 45% and that of the other accessories like transformers, cables, Inverters, civil works, etc. comes to about 55%. Additionally, the cost of the power plant also depends on the land value. As the cost of solar photovoltaic is continuously decreasing, the major challenge now lies on the land cost. Land is becoming a scarce resource in India in recent years, and per capita land availability is low. Land is often considered as the topmost challenge for deploying solar energy technology. In view of the above, the study is based on using the available land in an effective way.

2. There are other approaches and methods of using solar photovoltaic technology on highways, for example, using solar-powered LED roadway lighting, security lighting, highway changeable message, etc. Although these are very important applications, in terms of power generation or power saving, they are almost negligible in comparison to the approach that it has suggested in this paper. Also, one can see the cost-oriented modeling and design optimization for alignment to determine operation and engineering cost of the highway.

3. The rationale behind the proposed study is to explore the effectiveness of using the national highway and to enlarge all the factors to generate energy. The additional advantage of using the space above the road highways for installation of solar panels is the shading on the roads. This results in improved vehicle efficiency by reducing energy losses due to heat inside the vehicle and also improves the life of the tires of all vehicle wheels due to the shade derived from the road.

4. One needs to take care of fixing the solar panels to the base firmly onto the structure. Fixing the solar panels at an elevated location, say about 9 to 10m above the ground level, is vulnerable to heavy wind during the storm or rainy days. It may pose a problem for the stability of the solar panels as compared to the ones close to the ground. With extra care of fixing, the panels may overcome this problem.

5. Another problem may be from the dust and smoke particles due to movement of the vehicles. However, as many national roadways are wide and generally much cleaner than other roads, for example, village roads, narrow city roads, or state roads, in any case, one needs to make special arrangement of cleaning the panels on a daily basis as compared to normal panels on the ground away from the road traffic or remotely located panels, where cleaning of panels is done once in a week or 10 days

III. RESEARCH ANALYSIS

The primary objectives of this study can be summarized as follows.

1) an approach to utilize solar energy to meet the global challenges like climate change, pollution, and energy insecurity and also to address the biggest challenge for the photovoltaic technology, i.e., land cost.

2) Main objective of this road rooftop solar project is increase of the life of the road from wear and tear on the highways, and this helps to reduce the fund requirement for road repairs. Another benefit is rainwater harvesting at selected locations.

1. Modelling of photovoltaic Solar Panels.
2. Minimization of area required for solar Photovoltaic generation.
3. Design of two level solar panel and its utilization one over another.
4. Implementation of Solar concept throughout national highways.
5. Observing the Power generation output in national highways.

1. MAINTAINCE COST: They are more because road surface accumulate rubber, salt, soil and other substances that block sunlight and must be removed. The durability of the panels may also be less, further increasing maintenance cost.

2. SESSANAL EFFICIENCY: In India the solar road will work efficiently in summer, while it will give comparatively less efficiency in other seasons due to lack of solar radiation. Where as in the countries where summer last for more than half of year this technique can be efficiently used.

3. NEEDS A TOWN PLANING: If these roads are to be used town planning plays a vital role as these roads needs a accurate orientation of buildings, roads, sanitary lines, parking lots, playground etc.

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IV. SAFETY AND SECURITY ADVANTAGES

As previously mentioned, there is an undeniable advantage to solar roadways over other impermeable surfaces with regards to safety and security. Asphalt or concrete driveways are a liability to the owner because of the fact that they do not provide any added benefits after they are installed and eventually will need repair or replacement. On the contrary, solar roadway type driveways would provide financial security, and return on investment to the owner through solar power, as well as never needing a full replacement. The safety of asphalt roadways becomes compromised when driving conditions are not ideal; however, the opposite is true for solar roadways. When inclement weather occurs, which the computerized roadway will know ahead of time, solar roadways adjust to the weather through the utilization of heating elements and LED road lighting [3]. Heating elements in the hexagonal solar panels will melt away any snow and provide better driving traction which will ultimately lead to less accidents in the winter months. LEDs will provide brighter and clearer signage of the roadway as well as overall improved illumination at night [3]. Both of these notable aspects are dynamic, meaning they are capable of adapting to a variety of circumstances, which is something that asphalt roadways will never be able to achieve.

V. CONCLUSION

In future, normal roads can be replaced by the solar roadways but huge initial investment is required. The solar roadway alternative could be made at less cost with an energy return while phasing out the old system. AS old Roads are scheduled to be under maintenance, the process of solar roadway placement could occur seamlessly. The alternative of airports and parking lots are under varying timelines.

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